

National Aeronautics and Space Administration



IPPW-7 The SAGE New Frontiers Mission to Venus

SAGE – Surface and Atmosphere Geochemical Explorer

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Jet Propulsion Laboratory

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Government sponsorship acknowledged

SAGE Science Objectives

- **Why is Venus so different from Earth?**
 - Measure noble gases, isotopes, and sulfur compounds
- **Was Venus ever like Earth?**
 - Measure surface and subsurface composition at volcanic hotspot
 - Determine surface rock type, mineralogy, and texture
 - Provide ground truth for Magellan images and VIRTIS emissivity
- **Does Venus represent Earth's fate?**
 - Model the history of Venus and predict its future
 - Predict observable characteristics of Venus-like extrasolar planets

SAGE Team



Ames Research Center
Langley Research Center
Goddard Space Flight Center



SAGE Team

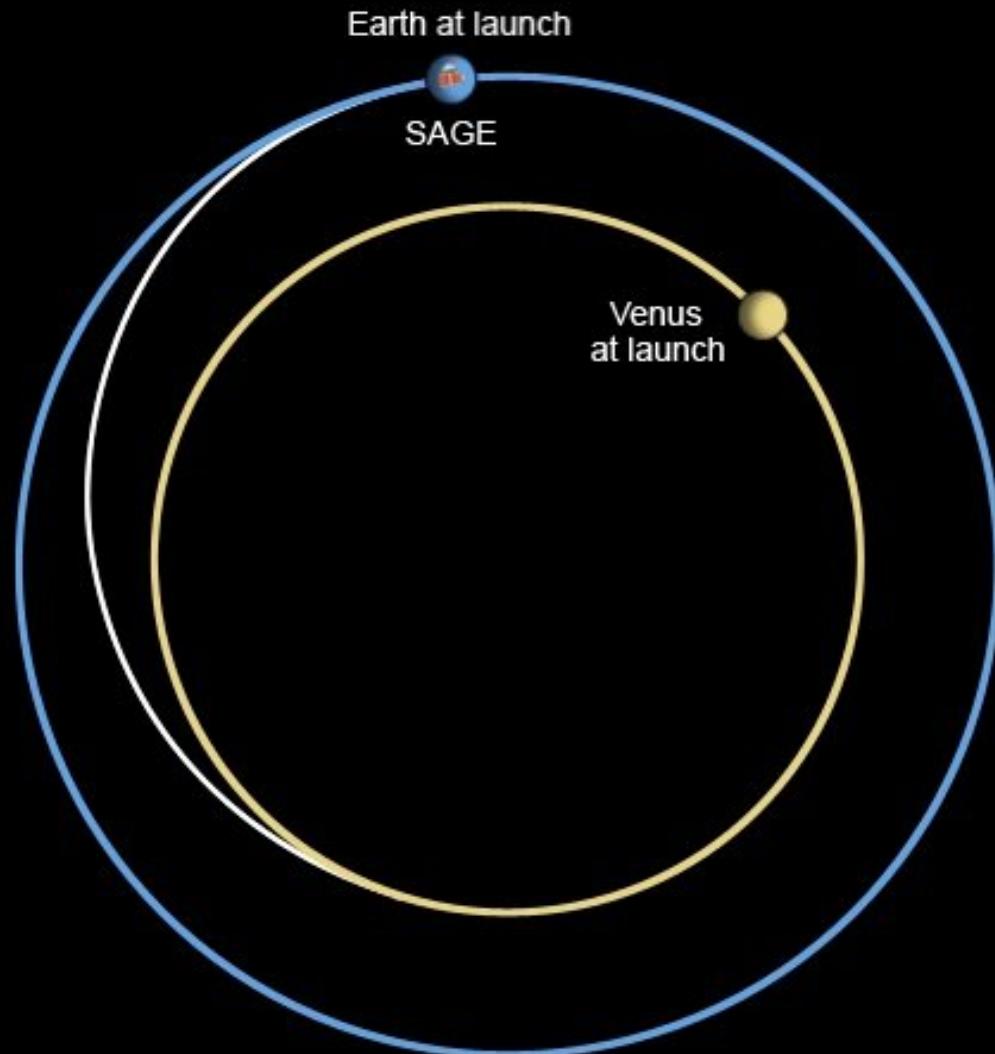
- **Laboratory for Atmospheric and Space Physics (LASP)**
 - Larry Esposito, PI
 - Science data archive
 - E/PO
- **Jet Propulsion Laboratory (JPL)**
 - Sue Smrekar, Deputy PI
 - Project Management
 - Project Systems Engineering
 - Mission Management
 - Lander
 - EDL
 - Tunable Laser Spectrometer (TLS)
- **Lockheed Martin**
 - Carrier
 - Entry and Extraction Subsystem (EES)
 - Flight system ATLO
- **NASA Ames and NASA Langley**
 - Technical support of Venus atmospheric entry and descent
- **NASA Goddard**
 - Neutral Mass Spectrometer (NMS)
- **Russian Space Research Institute (IKI)**
 - Flyby Camera (FBC)
 - Neutron-Activated Gamma-Ray Spectrometer (NAGRS)
- **Malin Space Science Systems (MSSS)**
 - Descent and Panoramic Cameras (DPC)
 - Microscopic Camera (MC)
- **Los Alamos National Laboratory (LANL)**
 - Raman and Laser-Induced Breakdown Spectroscopy (Raman/LIBS)
- **Canadian Space Agency (CSA) and MacDonald, Dettwiler and Associates Inc. (MDA)**
 - Surface Excavation Subsystem (SES)
- **Centre National d'Etudes Spatiales (CNES) and Centre d'Etudes Spatiale des Rayonnements (CESR)**
 - Lasers for Raman/LIBS Instrument

Science Team

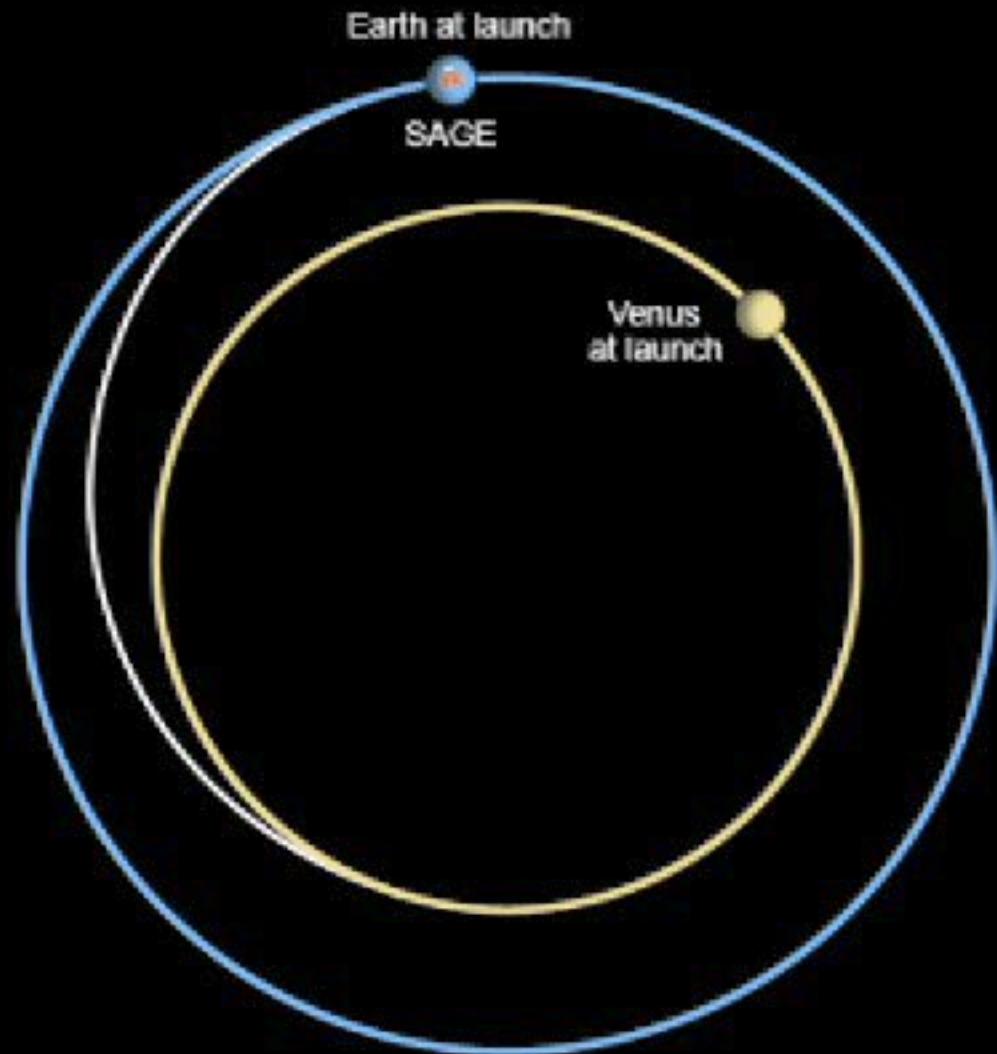


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|--------------------------------|-----------------------------|--------------------------------|----------------------------|
| • Larry Esposito (LASP) | • David Crisp (JPL) | • Oleg Koralev (IKI) | • Nicolas Thomas (U. Bern) |
| • Sue Smrekar (JPL) | • Darby Dyar (Mt. Holyoke) | • Paul Mahaffy (GSFC) | • Dmitriy Titov (MPS) |
| • David Atkinson (U. Idaho) | • Lindy Elkins-Tanton (MIT) | • Sylvestre Maurice (CNES) | • Allan Treiman (LPI) |
| • Bill Boynton (UA) | • Larry Evans (GSFC) | • Hap McSween (U. Tenn.) | • Alan Wang (Wash U.) |
| • William Brinckerhoff (GSFC) | • David Grinspoon (DMNS) | • Igor Mitrofanov (IKI) | • Chris Webster (JPL) |
| • Mark Bullock (SwRI) | • James Head (Brown) | • Michael Ravine (MSSS) | • Roger Wiens (LANL) |
| • Bruce Campbell (Smithsonian) | • Mihály Horányi (LASP) | • Shiv Sharma (U. Hawaii) | • Yuk L. Yung (Caltech) |
| • Sam Clegg (LANL) | • Catherine Johnson (UBC) | • Richard Starr (GSFC) | • Kevin Zahnle (ARC) |
| • Tony Colaprete (ARC) | • Viktor Kerzhanovich (JPL) | • Ellen Stofan (Proxemy Corp.) | |

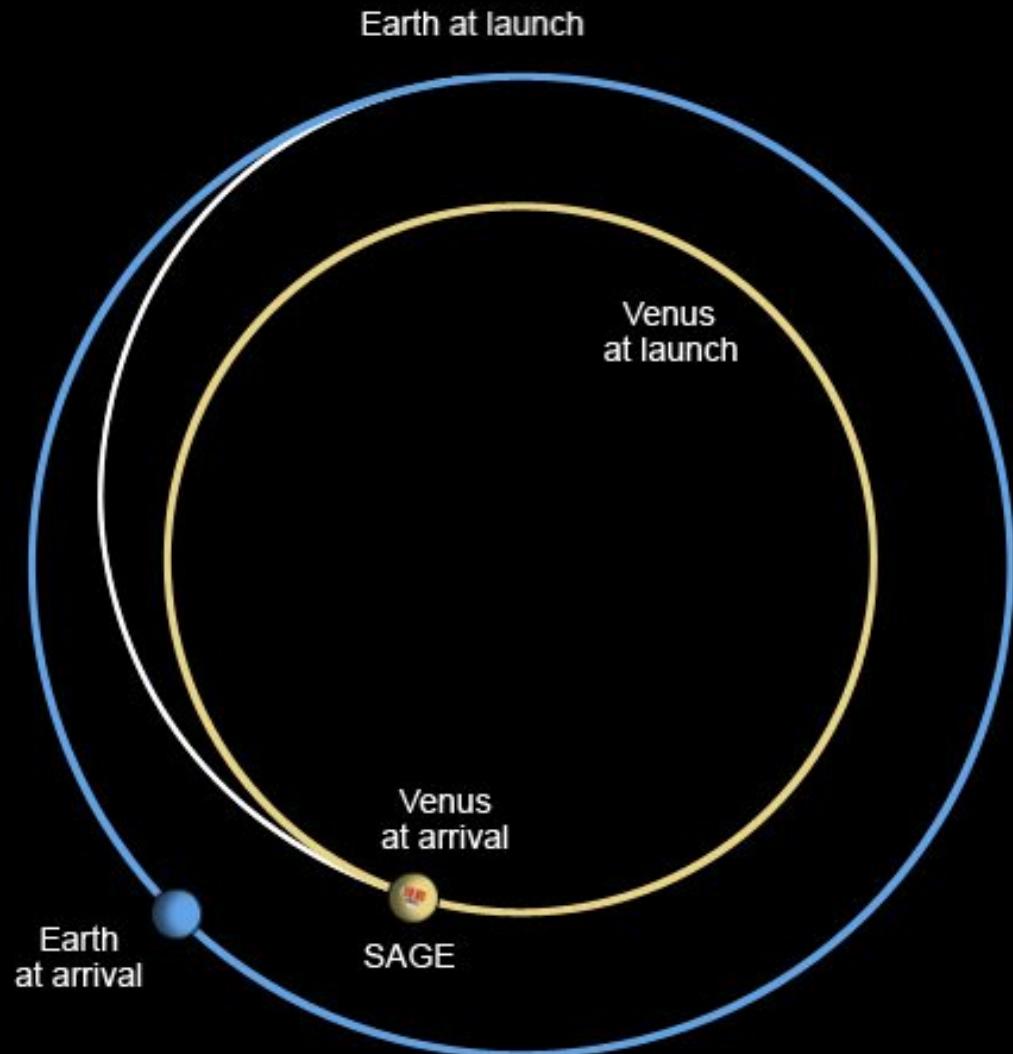
SAGE Mission



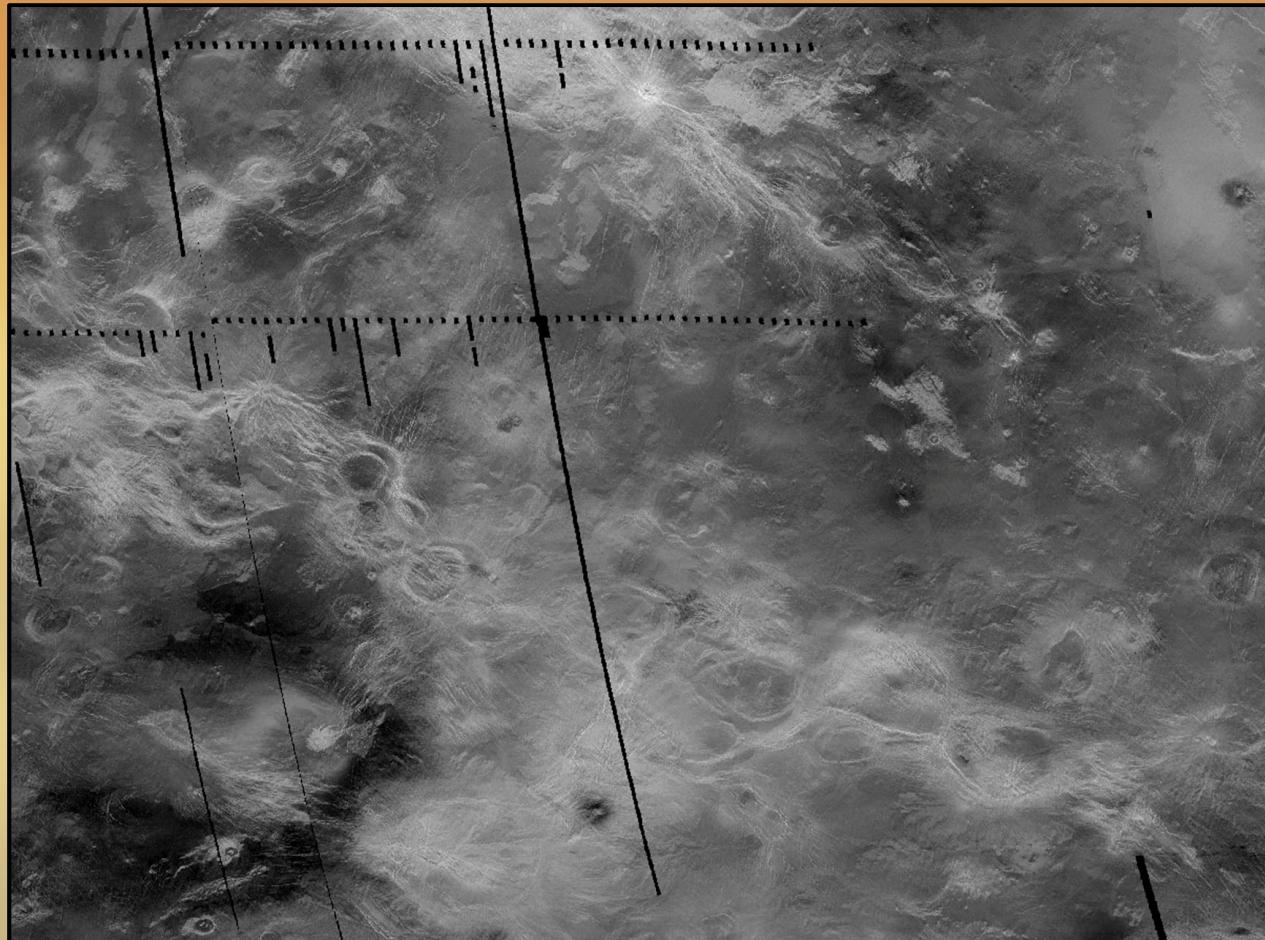
SAGE Mission



SAGE Mission



SAGE Landing Site (SAR Image Data)



SAGE Landing Site (Emissivity)

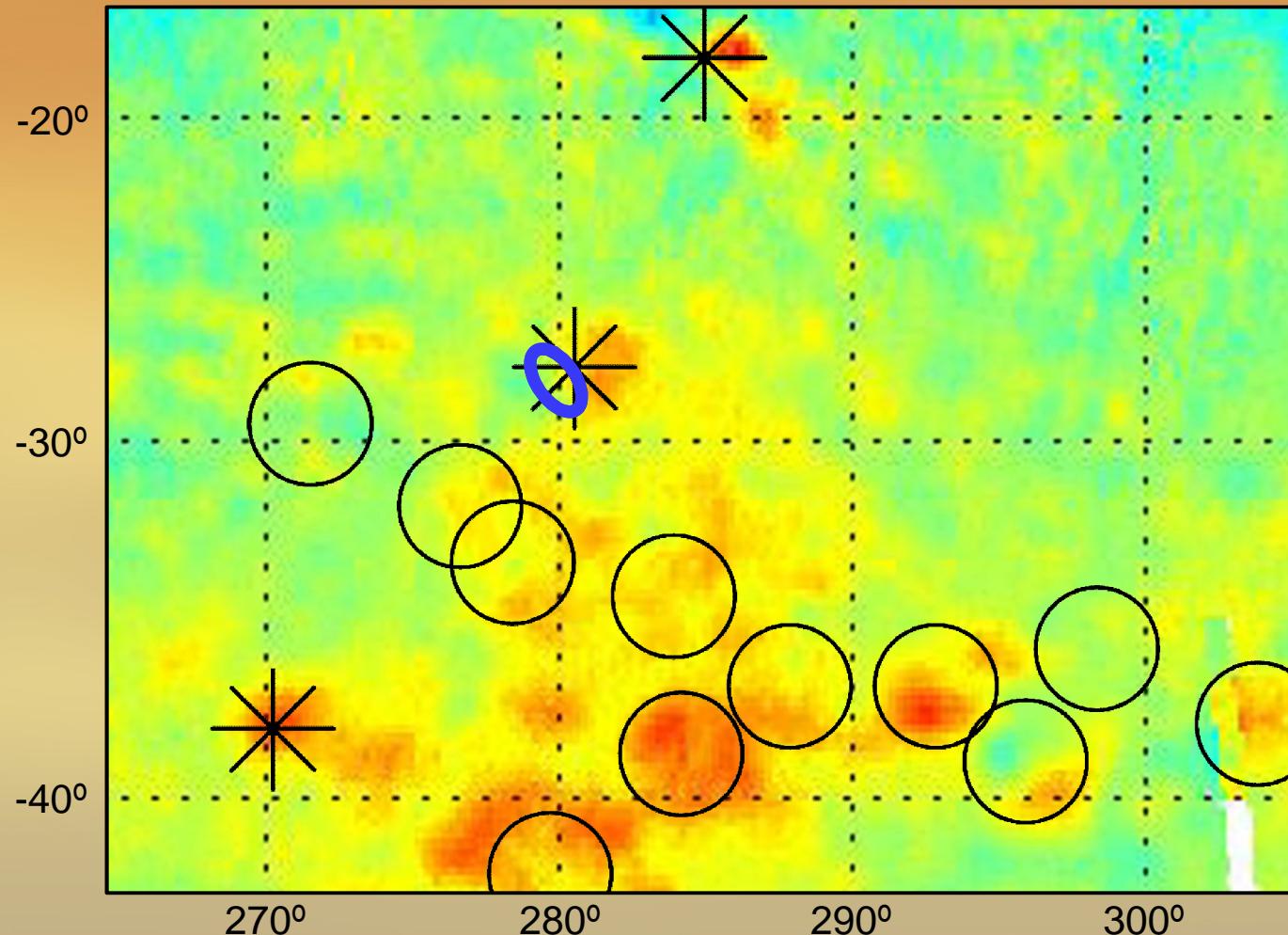
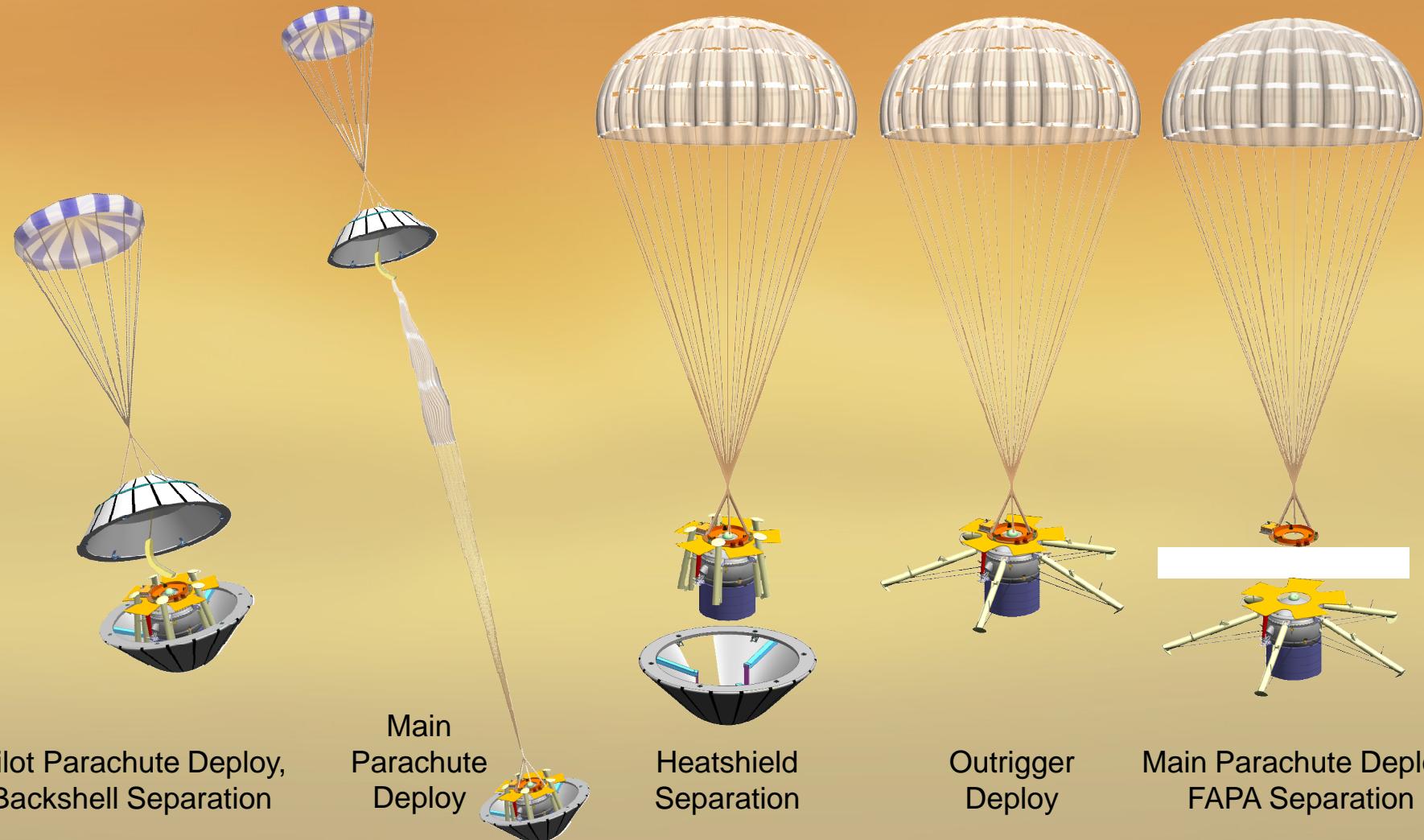


Image courtesy VIRTIS, Venus Express, ESA
Helbert, et.al. 2008, Mueller, et. al. 2008

Descent Staging



Pilot Parachute Deploy,
Backshell Separation

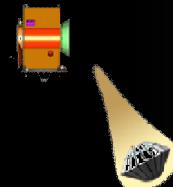
Main
Parachute
Deploy

Heatshield
Separation

Outrigger
Deploy

Main Parachute Deploy,
FAPA Separation

Instruments and Providers



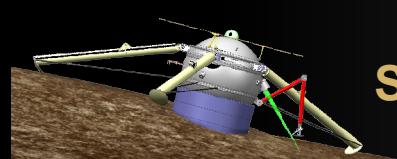
Atmospheric Dynamics

- Flyby Camera (FBC); IKI (on Carrier)
- Atmospheric Structure Investigation (ASI): T, P, Wind, & IMU; ARC
- Doppler Wind Experiment (DWE); U-Idaho / JPL



Atmospheric composition

- Neutral Mass Spectrometer (NMS); GSFC
- Tunable Laser Spectrometer (TLS); JPL



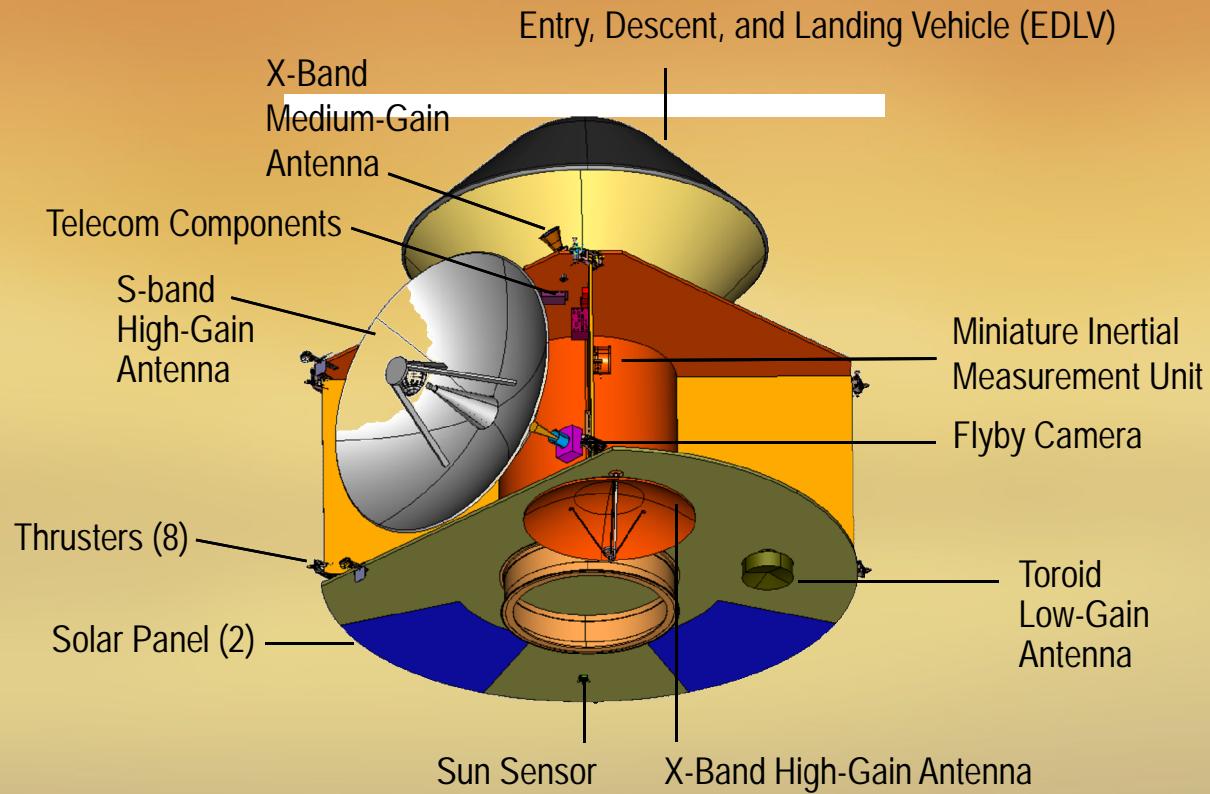
Surface Geology and Weathering

- Descent / Panoramic Camera – Microscopic Camera (DPC/MC); MSSS

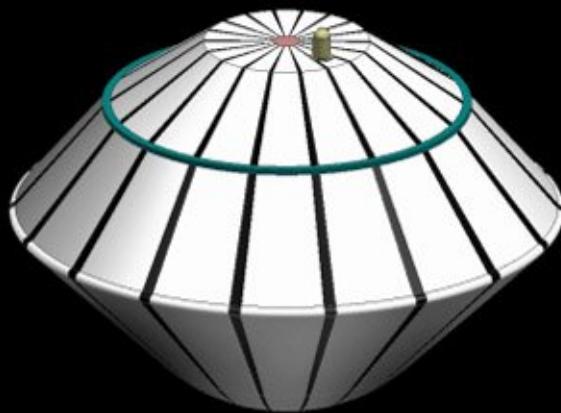
Surface Composition and Mineralogy

- Neutron-Activated Gamma-Ray Spectrometer (NAGRS); IKI
- Raman/Laser Induced Breakdown Spectroscopy (Raman/LIBS); LANL

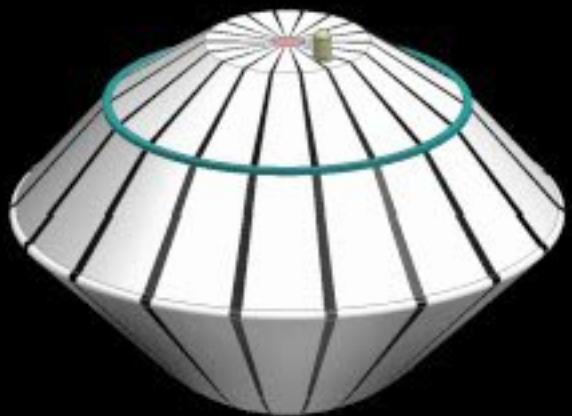
SAGE Flight Elements – Carrier



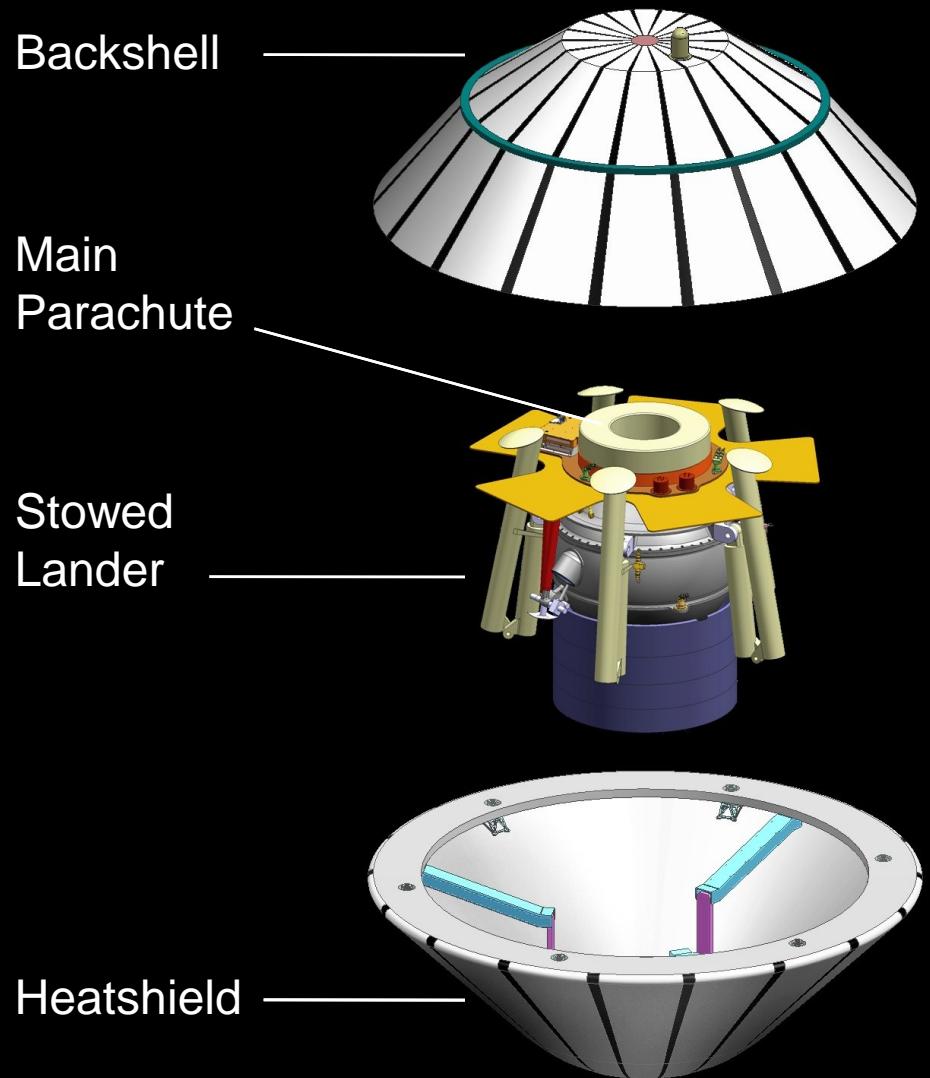
SAGE EDLV



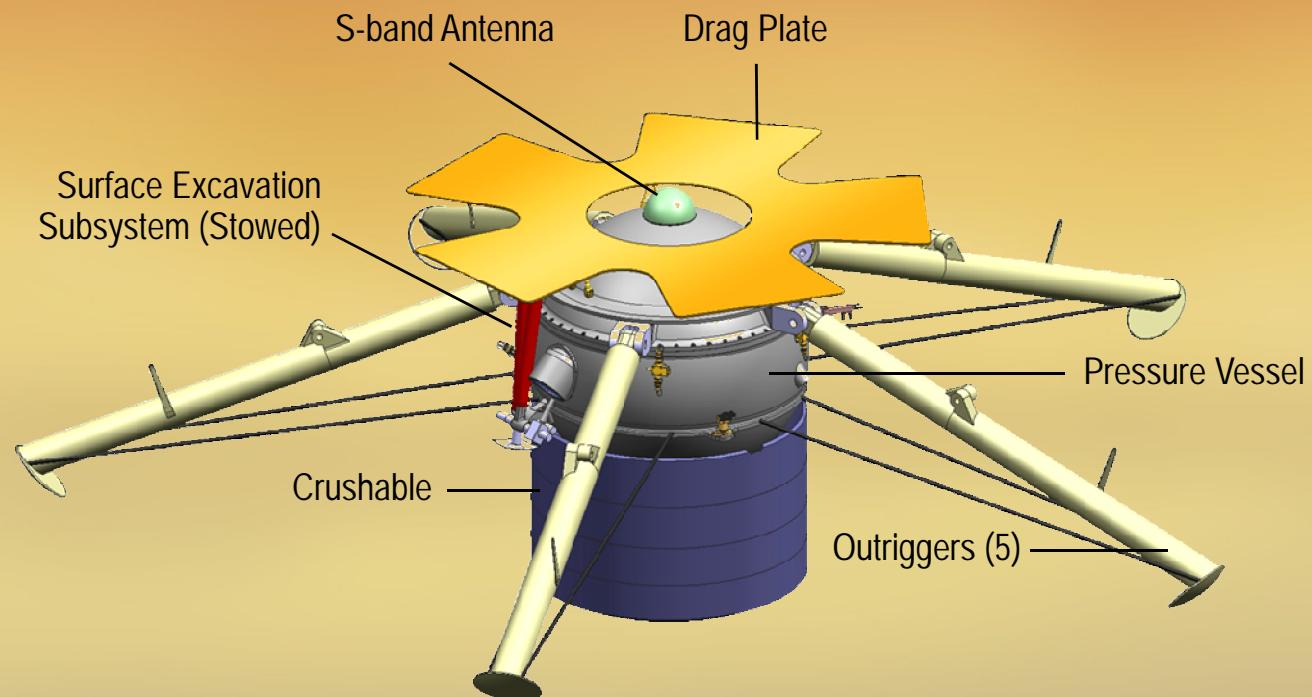
SAGE EDLV



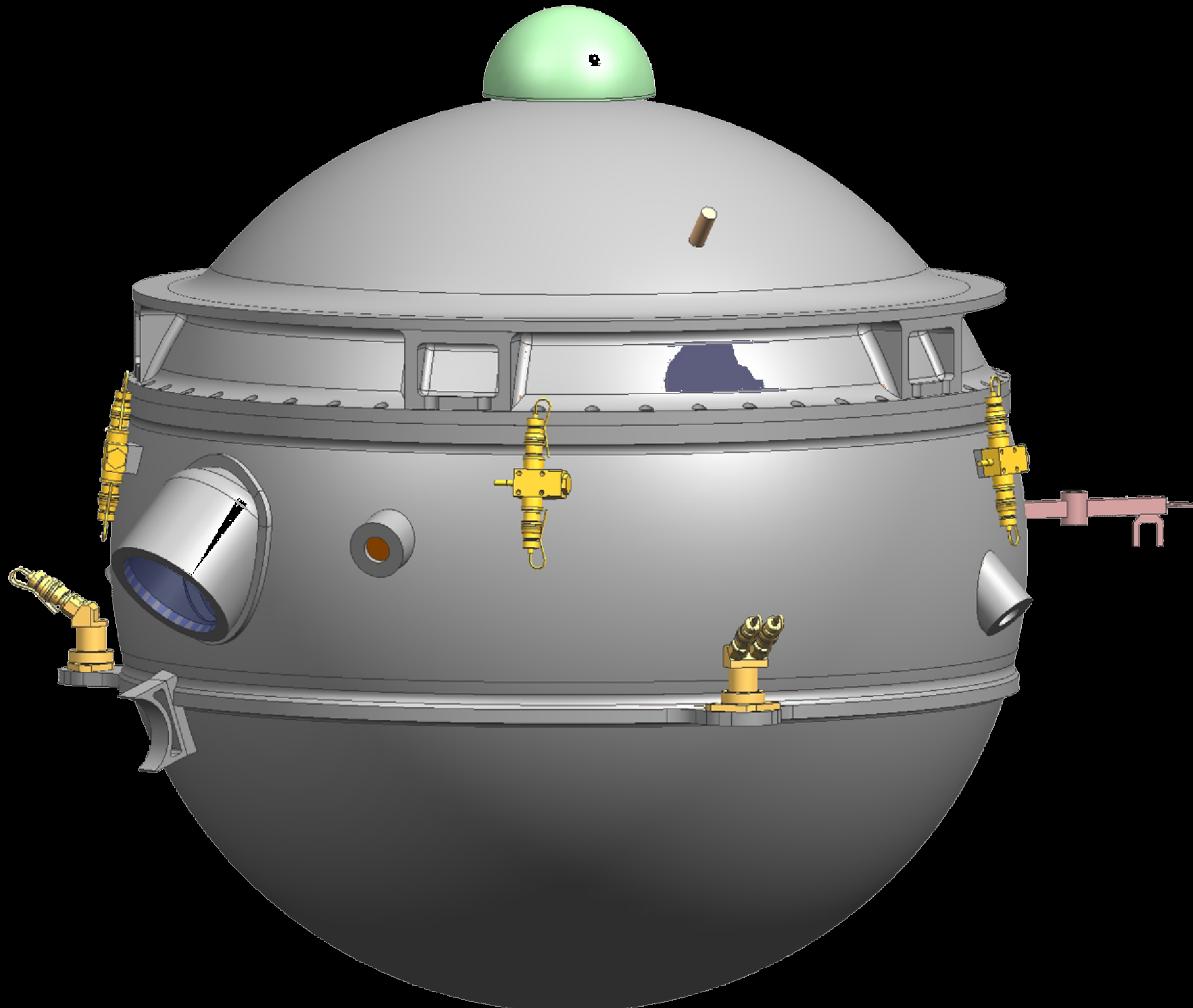
SAGE EDLV



SAGE Lander



Lander Pressure Vessel



SAGE Descent and Surface Mission